HIGH-RESOLUTION GEOPHYSICAL AND GEOLOGICAL INVESTIGATION OF LATE QUATERNARY DEFORMATION IN THE LOWER WABASH VALLEY FAULT ZONE

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INVESTIGATIONS UNDERTAKEN

We are investigating the spatial and temporal characteristics of recently discovered neotectonic deformation in the southernmost part of the Wabash Valley Fault System (WVFS), near the northern New Madrid seismic zone (NMSZ) boundary suggested by Wheeler (1997) (Fig. 1). Systematic field investigations are integrating high-resolution shear-wave (SH mode) seismic reflection/refraction profiling, ground-penetrating-radar imaging and correlative drilling. The work is an outgrowth of a geotechnical investigation wherein indications of neotectonic deformation extending above the Pennsylvanian bedrock into late Quaternary-aged sediment were found. These discoveries lie in a region that previous, lower-resolution investigations had found no deformation later than pre-Pleistocene.

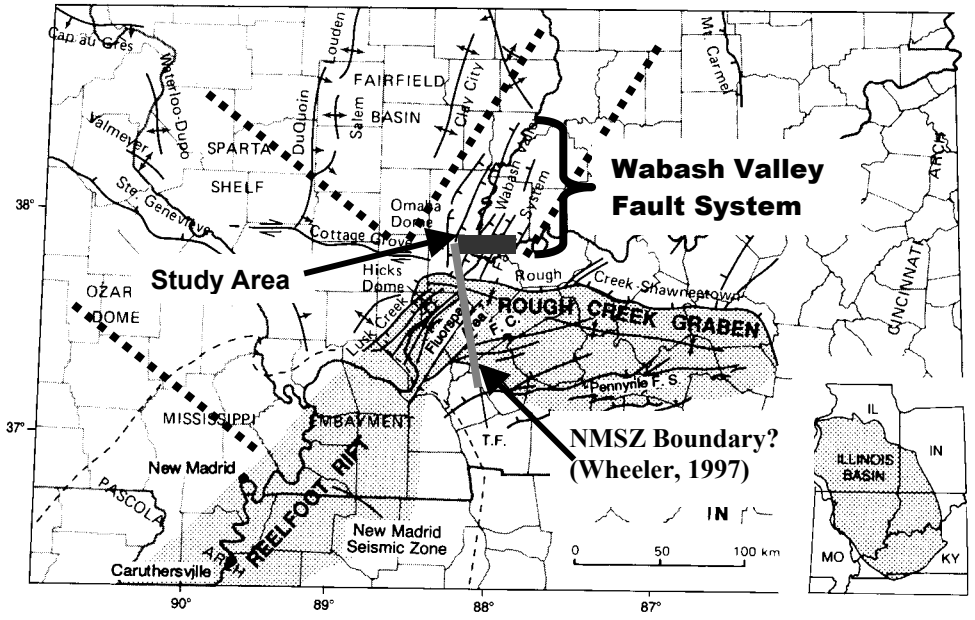

Figure 1. Regional structural features in the central U.S. (modified from Kolata and Hildebrand, 1997) and inferred quadruple junction (heavy dashed line) from Braile et al. (1986). The study area is shown as the heavy shaded area in the lowermost part of the Wabash Valley.

During the late spring and summer of 2004, approximately 8 kilometers of seismic reflection data have been acquired in the vicinity of the Wabash Island (WIF) and Hovey Lake faults (HLF) (Fig. 2). Site conditions have required much denser sample spacing (group interval) than was originally anticipated. The 8 km of seismic data were collected by high-resolution SH-wave methods.

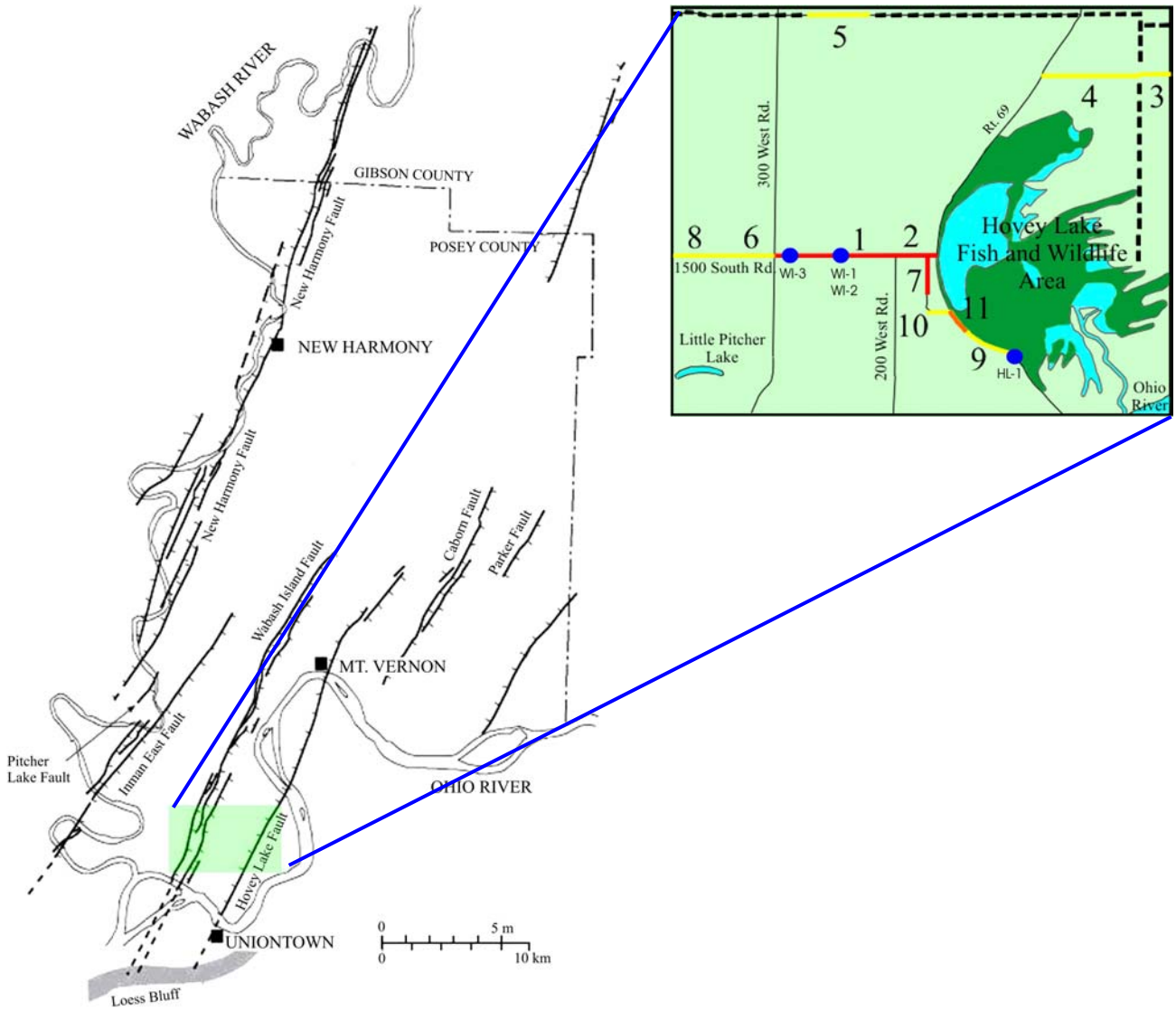

Figure 2. Locations of seismic surveys. The orange line represents data collected at a 1-m group interval, the red lines represent a 2-m group interval, and the yellow lines represent a 4-m group interval. Numbers represent line number. The blue circles represent borehole locations of WI-1, WI-2, WI-3, and HL-1. The black dashed lines are the locations of deeper seismic-reflection profiles that imaged Hovey Lake fault and Wabash Island fault at depth (Rene and Stanonis, 1995). Another reflection survey conducted by Rene and Stanonis (1995) is located just west of Line 8

Additional work planned for the project includes the acquisition of 1 to 2 kilometers of ground-penetrating-radar profiling over some of the more prominent imaged anomalies. Additional drilling and potential carbon-dating are also planned.

RESULTS

Approximately 8 kilometers of high-resolution SH-wave seismic reflection profiles have been collected across the Mt. Vernon graben, a 35 km by 3 km graben (bounded by the WIF and HLF) in the southern WVFS of southern Indiana. Forty-six discrete faults were interpreted to displace Quaternary sediment (average displacement ~1.7 m) in the vicinity of the WIF and HLF. The structural styles associated with the faults include: 1) predominantly normal displacement in bedrock, 2) significant reverse displacement and other compressional features in the soil horizons, 3) varying magnitudes of slip along fault planes, and 4) different senses of slip along fault planes. Initial carbon-14 dating of deeper displaced horizons suggests an upper bound for reactivation ranging between approximately 26,000 and 42,000 YBP.

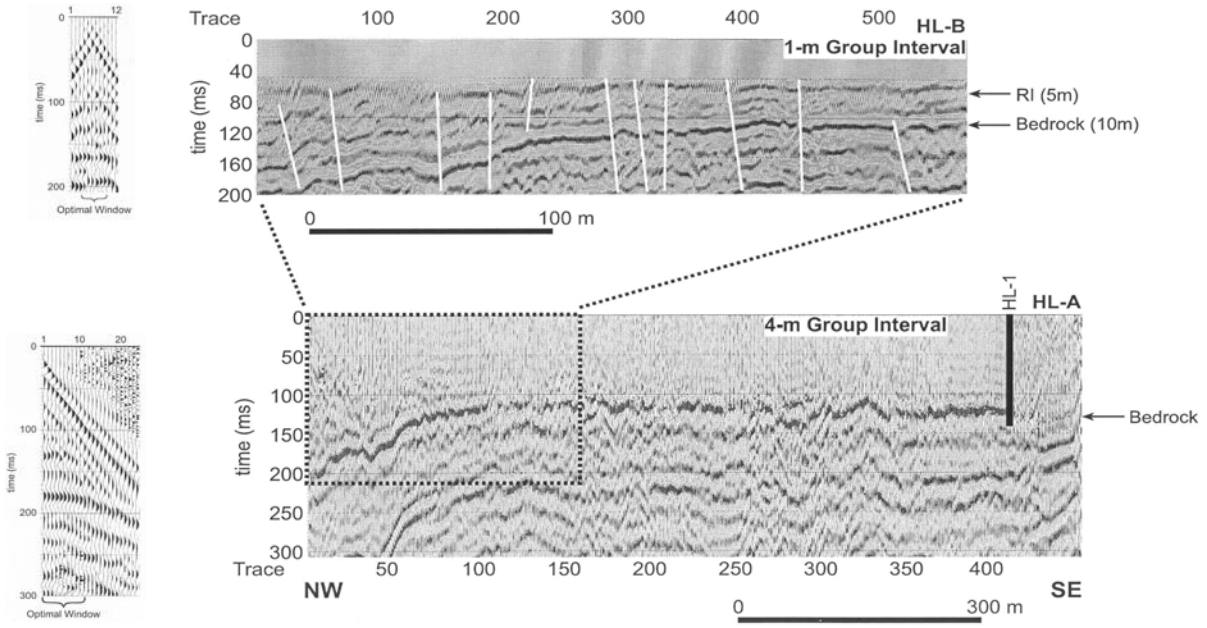

Figure 3. Example field files and stacked profiles collected coincident over the Hovey Lake fault (Line 9-HL-A, 6-fold, and Line 11-HL-B, 3-fold). HL-B was collected at a denser spacing in order to sample soil overburden. The location of borehole HL-1 relative to the profiles is shown on profile Line 9-HL-A.

NONTECHNICAL SUMMARY

Subsurface images of deformed sediments within the southern Wabash Valley are providing direct physical evidence of relatively recent tectonic activity. The images are enabling us to estimate the time of movement, as well as, to understand the style and geometry of the deformation. Results have shown that deformation extends to within at least 5 meters of the ground surface. Preliminary age estimates suggest that an upper bound for fault movement ranges between 26,000 and 42,000 BP.

There are limitations to the resolving power of each geophysical technique being used; consequently, the exact timing of the latest tectonic episode at some locations will be uncertain.

In such instances, we hope to coordinate with, and provide target information to, researchers specializing in paleoseismologic trenching.

PUBLICATIONS/PRESENTATIONS

Woolery, E., *in review*, Geophysical and geological evidence of neotectonic deformation along the Hovey Lake fault, Lower Wabash Valley Fault System, Central United States: **Bulletin of the Seismological Society of America**.

Woolery, E., Rutledge, F., Wang, Z., 2004, Geophysical and Geological Evidence of Neotectonic Deformation Along the Hovey Lake Fault, Lower Wabash Valley Fault System, Central United States: Eos Transactions AGU***, 85*(46), Fall Meet. Suppl., Abstract S53C-06**.

DATA AVAILABILITY

SH-wave seismic reflection/refraction and GPR data acquired in the study are being organized by site, and will be archived at the Kentucky Geological Survey as field and stacked files. There will also be information as to the location of the site, recording parameters, and other pertinent information. The seismic data will be stored in standard SEG-Y format at the completion of the study, and available upon request. Requests for information should be directed to the PI.

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